1. UPPER CRETACEOUS POLLEN GRAINS FROM EGYPT I.

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Abstract

The LM results of the spores of our material of investigation were published in 1995. This contribution deals with the taxonomical elaboration of the greatest part of the *gymnosperm* pollen grains, except the monosulcate forms. During our investigations specimens of the following form-genuses were revealed: *Callialasporites, Alisporites, Cupressacites, Balmeiopsis, Araucariacites, Classopollis, Corollina, Eucommiidites, Ephedripites, Steevesipollenites.* One form-genus (*Stoveripollenites*) with one species (*S. africanus*) and the following new form-species were described herein: *Cupressacites farafraensis, C. khargaensis, Ephedripites brenneri, E. ameromii, E. coetzeae, E. krempii, E. boltenhagenii, E. rakosii, E. jansoniusii, Steevesipollenites khargaensis, S. elsikii.* The new form-subspecies are as follows: *Araucariacites australis aegypticus, Ephedripites minimus aegypticus, E. winiae magna.*

Key words: Palynology, fossil, *Gymnospermatophyta*, Upper Cretaceous, Egypt.

Introduction

The publication of the systematic elaboration of the sporomorphs of the samples collected in Egypt started not long time ago (1995). After the monographic elaboration of the spores, the pollen grains will be described and published in consecutive series of publications. The chapter "Materials and Methods" will not be repeated again and again this may be found in the monograph of the spores (KEDVES 1995, p. 15). As regards the evaluation and the discussion of the taxonomical data, this is planned as a terminal part of this series.

Systematic descriptions

ANTETURMA: *POLLENITES* R. POTONIÉ 1931
TURMA: *SACCITES* ERDTMAN 1947
SUBTURMA: *MONOSACCITES* (CHITALEY 1951) R. POTONIÉ and KREMP 1954
INFRATURMA: *ALETESACCITI* LESCHIK 1955

Form-genus: *Callialasporites* DEV 1961

VENKATACHALA and KAR (1969) discussed in detail the morphology of these pollen grains (under the name *Applanopsis*). POCOCK (1968) in a discussion of the taxonomy of the "*Zonalapollenites* group" wrote the following; p. 640: "It therefore seems desirable

to retain *Callialasporites* to encompass the morphologically well defined group for which it was erected." An important comparative table on the main distinguishing characters of the different species and forms of this genus was published by FILATOFF (1975), p. 83.

1. *Callialasporites dampieri* (BALME 1957) DEV 1961
(Plate 1.1., figs. 1,2)

Syn.: 1957 *Zonalapollenites dampieri* BALME, p. 32, pl. 8, figs. 88, 90.
1961 *Callialasporites dampieri* (BALME) DEV, p. 48, pl. 4, figs. 26,27.
1961 *Applanopsis dampieri* (BALME) DÖRING, p. 113, pl. 16, figs. 11–15.
1962 *Pflugipollenites dampieri* (BALME) POCOCK, p. 72, pl. 12, figs. 183,184.
1963 *Tsugaepollenites dampieri* (BALME) DETTMANN 1963, p. 100, pl. 24, figs. 1–5.

Description: Amb circular to elliptical, the surface is finely granulate, the zone (=bladder) is 5–7 µm wide and radially folded.

Diameter: 63 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent.

SUBTURMA: *DISACCITES* COOKSON 1947
INFRATURMA: *PINOSACCITI* (ERDTMAN 1947) R. POTONIÉ 1958

Form-genus: *Alisporites* DAUGHERTY 1941

1. *Alisporites* cf. *bilateralis* ROUSE 1959
(Plate 1.1., figs. 3,4)

Description: Surface of the pollen grain is granulate, the marginal crest 3–4 µm thick, the infratectal layer is alveolar with radially oriented structure elements. The tectum and the foot layer are very thin. Amb of the bladders are semicircular, surface scabrate, the outer alveolae are 2 µm, the inner 3–5 µm in diameter.

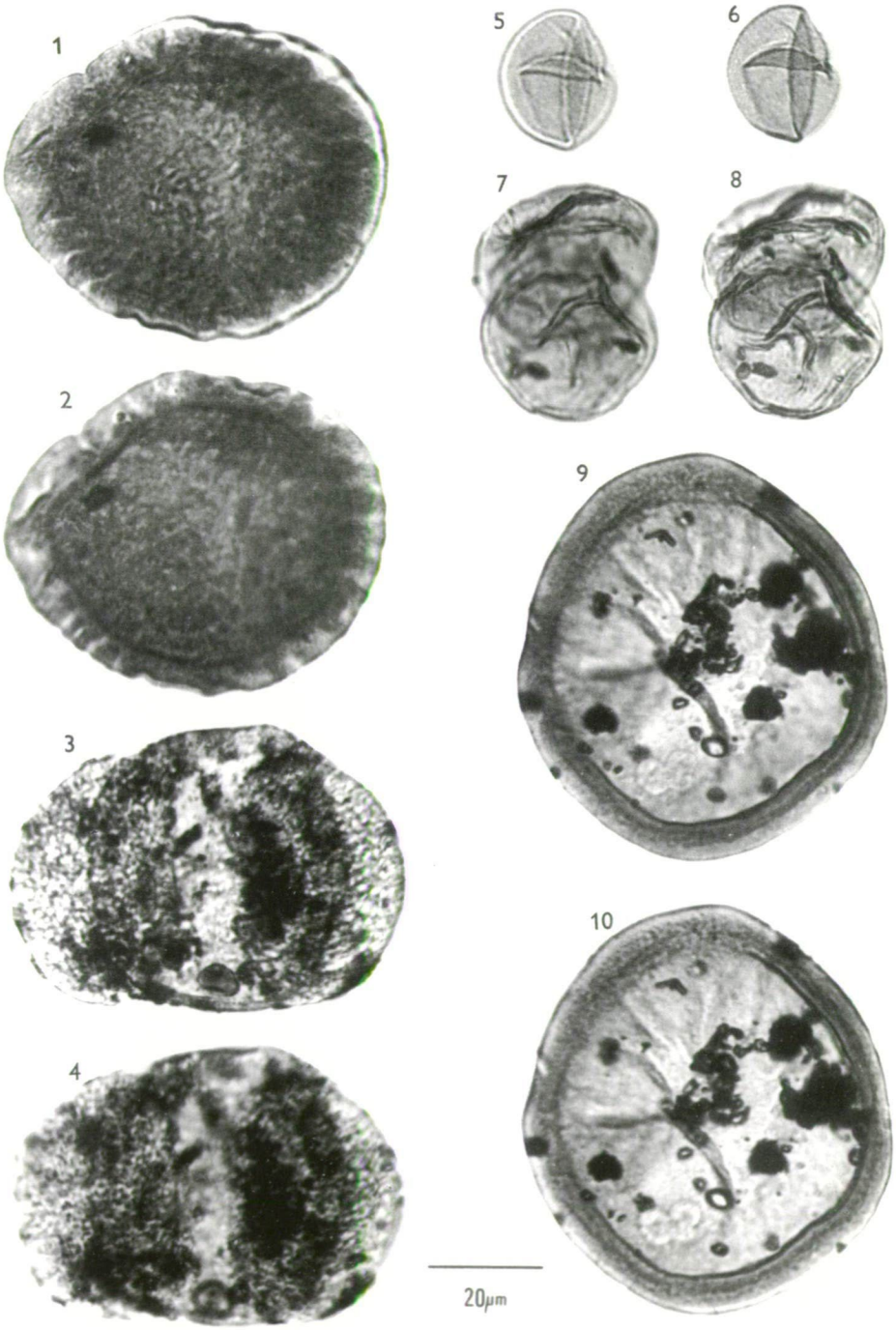
Total diameter: 67 µm.

Occurrence and frequency in the samples investigated from Egypt: Coniacian-Santonian: Abu Rauwash (70-1-7-1) infrequent.

TURMA: *ALETES* IBRAHIM 1933
SUBTURMA: *AZONALETES* (LUBER 1935) R. POTONIÉ and KREMP 1954
INFRATURMA: *PSILONAPITI* ERDTMAN 1947

SEM data concerning this pollen group from the Mesozoic of the Sahara were published by REYRE (1970).

Form-genus: *Cupressacites* BOLKHOVITINA 1956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20μm

Relatively small inaperturate, isodiametric pollen grains, without ligula (papillus). Surface ornamented with tiny elements.

1. *Cupressacites farafraensis* n. fsp.
(Plate 1.1., figs. 5,6)

Diagnosis: Amb originally circular, secondarily deformed, without germinal aperture. Surface punctate, finely granulate, the diameter of the ornamental elements are 0.2–0.3 μm. The pollen wall is 0.3–0.5 μm thick.

Diameter: 25 μm; 23–28 μm.

Holotype: Plate 1.1., figs. 5,6, slide: Farafra-6-2-2-4; cross-table number: 18.2/118.9.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: From the locality type.

Differential diagnosis: *C. cuspidataeformis* (ZAKLINSKAYA 1957) KRUTZSCH 1971 is larger than *C. farafraensis*. *Taxacites sahariensis* REYRE 1973 and *Cupressacites oxycedroides* REYRE 1973 are irregularly ornamented with orbiculi.

Botanical affinity: ?*Cupressaceae*.

Occurrence and frequency in the samples investigated from Egypt: Coniacian-Santonian: Abu Rauwash (70-1-7-2) common, Duwi common; Middle Campanian: Duwi infrequent; Upper Campanian: Duwi common; Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Farafra (11) infrequent, Kharga (1-39) common, Kharga (1–28) common; Maestrichtian, fm. indet.: Oweina (1) common.

2. *Cupressacites khargaensis* n. fsp.
(Plate 1.1., figs. 7,8)

Diagnosis: Amb circular or secondarily deformed. No germinal aperture or exine thinning was observable on these pollen grains. Surface scabrate or very finely rugulate, the size of the ornamental elements is 0.2–0.5 μm thick.

Diameter: 20 μm; 18–30 μm.

Holotype: Plate 1.1., figs. 7,8 – the superior specimen –, slide: Kharga-1-39; cross-table number: 13.4/104.9.

Locus typicus: Kharga, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: From Kharga the type locality.

Botanical affinity: ?*Cupressaceae*.

Plate 1.1.

1,2. *Callialasporites dampieri* (BALME 1957) DEV 1961, slide: Abu Minquar-4-3-5, cross-table number: 8.6/102.4.

3,4. *Alisporites* cf. *bilateralis* ROUSE 1959, slide: 70-1-7-1-7, cross-table number: 8.3/111.1.

5,6. *Cupressacites farafraensis* n. fsp., ?*Cupressaceae*, slide: Farafra-6-2-2-4, cross-table number: 18.2/118.9.

7,8. *Cupressacites khargaensis* n. fsp., ?*Cupressaceae*, slide: Kharga-1-39, cross-table number: 13.4/104.9.

9,10. *Balmeiopsis limbatus* (BALME 1957) ARCHANGELSKY 1977, slide: Duwi-L. C.-4, cross-table number: 12.1/101.5.

Differential diagnosis: The smaller size clearly separates this species from *C. insulipapillatus* (TREVISAN 1967) KRUTZSCH 1971 and *C. bockwitzensis* KRUTZSCH 1971. The exine of *C. baccataeformis* (ZAKLINSKAYA 1957) KRUTZSCH 1971 is thicker than that of the described new species.

Occurrence and frequency in the samples investigated from Egypt: Upper Campanian: Duwi common; Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Kharga (1-39) infrequent.

Form-genus: *Balmeiopsis* ARCHANGELSKY 1977

1. *Balmeiopsis limbatus* (BALME 1957) ARCHANGELSKY 1977
   (Plate 1.1., figs. 9,10)

Description: Amb circular, but in general deformed. Inaperturate pollen grains, but on both "pole" there are thinned zones of the exine. This, and the characteristic, sometimes zone-like, thick equatorial exine is the most important characteristic feature of this pollen grain. The thickest part of the exine is 2–6 µm thick. Structure is irregular and spongy by the light-microscope.

Diameter: 70 µm; 54–80 µm.

Remarks: TEM data from the specimens obtained from the lower part of the Nubia Sandstone (Jurassic) were published by KEDVES and PÁRDUTZ (1974), cf. KEDVES (1994). The outer spongy structure seems to be a primitive character. SEM studies on Mesozoic specimens of the Sahara were made by REYRE (1973).

Occurrence and frequency in the samples investigated from Egypt: Lower Campanian: Duwi common; Maestrichtian, Nubia Sandstone: Kharga (1-28) infrequent, Maestrichtian, fm. indet.: Oweina (1) infrequent.

INFRATURMA: *GRANULONAPITI* COOKSON 1947

Form-genus: *Araucariacites* COOKSON 1947

Inaperturate, relatively large isodiametric pollen grains, with granulate to baculate sculpture. The first SEM data concerning this genus (cf. *Araucariacites* COOKSON) were published by REYRE (1968).

1. *Araucariacites australis* COOKSON 1947 ex COUPER 1953 subfsp. *aegypticus* n. subfsp.
   (Plate 1.2., figs. 1,2)

Diagnosis: Amb circular, generally secondarily deformed, no exine thinning, or germinal aperture. Surface granulate, the size of the sculptural elements from 0.2 to 0.6 µm, rarely anastomosent. The exine is 1–1.6 µm thick and two layered; the outer is formed by the elements of the sculpture; the inner layer is probably the endexine.

Diameter: 90 µm; 80–110 µm.

Subfsp. type: Plate 1.2., figs. 1,2, slide: Farafra-6-2-2-2; cross-table number: 21.4/111.5.

Stratum typcium: clayey brown coal.

Derivatio nominis: From Egypt.

Differential diagnosis: The greater size separates this species from *A. australis* subfsp. *australis*, according to the dimensions reported in the original diagnosis of COOKSON (1947) is 39–93 μm. It seems that the re-examination of this very common pollen type is necessary.

Botanical affinity: *Araucariaceae*.

Occurrence and frequency in the samples investigated from Egypt: Lower Campanian: Duwi infrequent; Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Kharga (1-28) infrequent.

TEM data: KEDVES and PÁRDUTZ (1974), KEDVES (1994).

2. *Araucariacites hungaricus* DEÁK 1964, *Araucariaceae*
(Plate 1.2., figs. 3,4)

Description: Inaperturate pollen grains, amb circular, but secondarily deformed. Surface granular, the size of the sculptural elements are 0.2–0.3 μm. The exine is 0.7–1 μm thick; two layered; an outer, granular ectexine and an inner, probably lamellar endexine.

Diameter: 55 μm; 52–58 μm.

Remarks: Diameter after DEÁK's (1964) original description: 32–58 μm. The diameter of the grana was not given. TEM data from KEDVES and PÁRDUTZ (1974) (=*Araucariacites* fsp.$_2$, Fig. 4; 1-5), the lamellar ultrastructure of the endexine is well shown on the pictures, in particular on 4;2 and 4;5. (cf. KEDVES 1994).

Occurrence and frequency in the samples investigated from Egypt: Coniacian-Santonian: Duwi infrequent, Middle Campanian: Duwi infrequent, Upper Campanian: Duwi infrequent, Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Farafra (11) infrequent, Duwi Range (100) infrequent, Kharga (1-39) common, Kharga (1-28) common, Maestrichtian fm. indet.: Oweina (1) infrequent, Oweina (3) infrequent.

3. *Araucariacites balinkaense* KEDVES 1974, cf. *Araucariaceae*
(Plate 1.2., figs. 5,6)

Description: Inaperturate pollen grains, amb circular secondarily deformed. Surface finely granular or rugulate, the size of the ornamental elements varies from 0.2 to 0.4 μm. The exine is 0.8–1 μm thick, the two layers are not well discernible by light-microscope.

Diameter: 47 μm; 38–50 μm.

Remarks: The size and the diameter of the ornamental elements are a little smaller than those of the Hungarian ones, but these differences seems to be within the species variation. TEM data: KEDVES and PÁRDUTZ (1974), and KEDVES (1994).

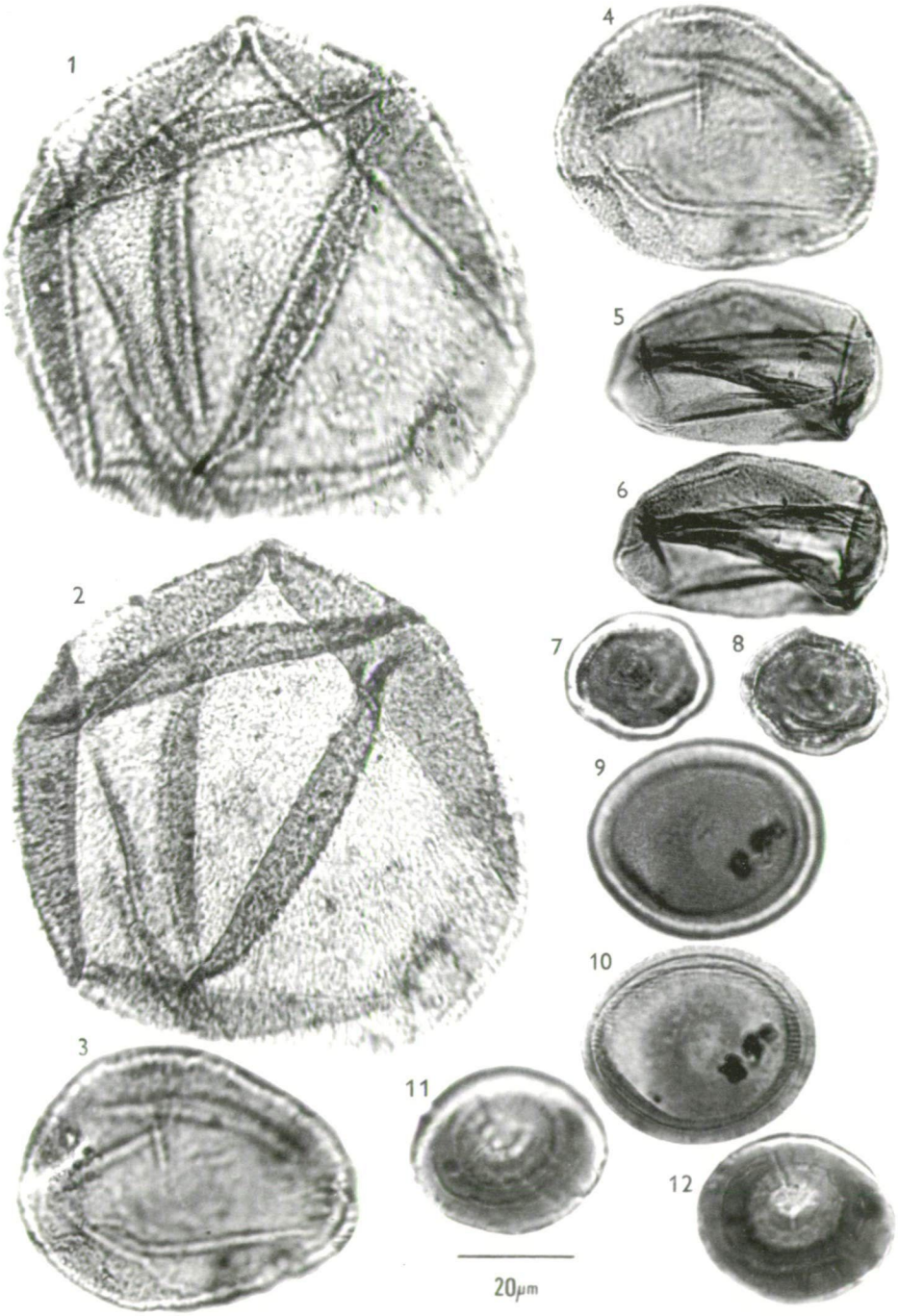
Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Kharga (1-39) infrequent.

INFRATURMA: *CIRCUMPOLLES* (PFLUG 1953) KLAUS 1960

The classification of KLAUS (1960) is as follows:

1. *Singulipollenites*
   Praecirculina, Partisporites, Paracirculina, Discisporites, Duplicisporites
2. *Tetradopollenites*
   Circulina, Corollina

VENKATACHALA and GÓCZÁN (1964) introduced the *Operculati* subturma.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BOLTENHAGEN (1968) discussed the problems of these pollen grains and proposed a new classification:

Circumpolles

1. *Zonocolpates – Proxapertites*
2. *Zonates – Canalulates – Aporina, Classopollis, Granuloperculatipollis, Classoidites, Corollina*

MÉDUS (1969, 1970) discussed the *Circumpolles* group, and distinguished the following tribes: *Circulinae, Eocorollineae, Gemmulineae, Eucorollineae, Lobelineae, Paracorollineae, Echinulineae, Corollineae.*

Basic, taxonomically important publications: MALYAVKINA (1949), PFLUG (1953), COUPER (1958), KLAUS (1960) and POCOCK and JANSONIUS (1961). CHALONER (1962) described in detail the diagrammatic reconstruction of *Classopollis torosus*. Further new species are described by BURGER (1965). REYRE, KIESER and PUJOL (1970) discussed the stratigraphic and geographic importance of some species of this form-genus. PONS and BROUTIN (1978) established that the pollen grains of *Frenelopsis oligostomata* ROMARIZ 1946 emend. ALVIN 1977 are similar to *Classoidites glandis* AMEROM 1965. ALVIN, SPICER and WATSON (1978) described *Classopollis* type associated pollen grains from the macrofossil *Frenelopsis parceramosa* (FONTAINE) WATSON. The SEM sculpture was also published. AZEMA (1979) described *Classopollis alata* which was obtained from the macrofossil *Frenelopsis alata* (K. FEISTM.) KNOBLOCH. The SEM method was also used during these investigations. The first TEM data of this form-genus was published by PETTITT and CHALONER (1964). Monographical elaboration by KEDVES (1994). REYRE (1970) emphasized that without SEM data it is difficult to identify these pollen grains. Further SEM data by KEDVES (1976). SRIVASTAVA (1976) discussed in detail all of the problems of this form-genus and published additional important SEM data.

Form-genus: *Classopollis* PFLUG 1953

1. Cf. *Classopollis* fsp.
   (Plate 1.2., figs. 7,8)

Description: In polar view, amb circular, secondarily deformed. On the proximal pole, the triangular tetrad scar is well discernible by light-microscope; 5–8 µm in diameter. The equatorial exine is 4–5 µm thick, tectate; the tectum is relatively thick, the

Plate 1.2.

1,2. *Araucariacites australis* COOKSON 1947 ex COUPER 1953 subfsp. *aegypticus* n. subfsp., *Araucariaceae*, slide: Farafra-6-2-2-2, cross-table number: 21.4/111.5.
3,4. *Araucariacites hungaricus* DEÁK 1964, *Araucariaceae*, slide: Farafra-6-2-2-1, cross-table number: 7.6/103.8.
5,6. *Araucariacites balinkaense* KEDVES 1974, cf. *Araucariaceae*, slide: Kharga-1-39-1, cross-table number: 16.4/117.1.
7,8. Cf. *Classopollis* fsp., slide: Oweina-1-4, cross-table number: 11.3/107.7.
9,10. *Classopollis perplexus* BOLTENHAGEN 1973, slide: Abu Minquar-4-3-2, cross-table number: 11.3/103.8.
11,12. *Corollina* fsp., slide: Abu Minquar-4-3-5, cross-table number: 15.7/101.5.

infratectal layer in optical section is columellar but forms an intrareticulate structure, so it is essentially alveolar. A relatively thin foot layer and probably an endexine is under the infratectal layer.

Diameter: 26 µm.

Remarks: TEM investigations are necessary to determine the exact structure of these pollen grains, which is probably very complicated, as was demonstrated first by PETTITT and CHALONER (1964).

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, fm. indet.: Oweina (1) infrequent.

2. *Classopollis perplexus* BOLTENHAGEN 1973
(Plate 1.2., figs. 9,10)

Description: Amb elliptic. Surface punctate or scabrate. The cryptopore are not so characteristic. The exine is 3–4 µm thick, its structure is not well discernible by the optical microscope. The endostriae are characteristic and number is about 20, a little more than those of BOLTENHAGEN's (1973) specimens.

Diameter: 40 µm; 36–44 µm.

Occurrence and frequency in the samples investigated from Egypt: Coniacian-Santonian: Abu Rauwash (70-1-7-2) infrequent, Lower Campanian: Duwi dominant, Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent, Kharga (1-28) common, Maestrichtian fm. indet.: Oweina (1) common.

Form-genus: *Corollina* (MALYAVKINA 1949) VENKATACHALA and GÓCZÁN 1964

This is the "older type" which generally occurs in Triassic layers. Its structure is simple, without striate equatorial bands.

1. *Corollina* fsp.
(Plate 1.2., figs. 11,12)

Description: Amb circular or secondarily deformed. Surface generally smooth. The polar scar on both sides are characteristic; a triangular and, respectively, a circular exine thinning, 9–10 µm in diameter. The equatorial exine is very thick (7–10 µm) its structure is not well discernible by optical microscope.

Diameter: 35 µm.

Remarks: Similar to the pollen grains of JARDINÉ and MAGLOIRE (1965, pl. 5, figs. 12,20; *Classopollis classoides* PFLUG) from Albian layers of the Ivory Coast and Senegal. Our specimens are probably recycled from older Mesozoic (Triassic) deposits.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent.

TURMA: *PLICATES* (-*PLICATA* NAUMOVA 1937, 1939) R. POTONIÉ 1960
SUBTURMA: *PRAECOLPATES* R. POTONIÉ and KREMP 1954

Form-genus: *Eucommiidites* ERTDMAN 1948

HUGHES (1961) described *Eucommiidites troedssonii* and *E. delcourtii* which are pollen grains observed in the micropyle and pollen chamber of *Spermatites pettensis* HUGHES 1961. The latter is Lower Cretaceous in age. This also supports the *gymnospermous* origin of *Eucommiidites*. DOYLE, M. VAN CAMPO and LUGARDON (1975) discussed in detail the different concepts concerning these pollen grains. They also described the results of SEM and TEM analyses of *Eucommiidites* sp. from the Aptian or Lower Albian (Potomac Group) of Delaware City. The surface is smooth, except for minute depressions or foveolae. The TEM structure is as follows: tectum with foveolae, the infratectal layer is granular, and there is an endexine. Further TEM and SEM data were published by TREVISAN (1980).

1. *Eucommiidites couperi* ANDERSON 1960
(Plate 1.3., figs. 1–4)

Description: Amb ellipsoidal, with three asymmetrical furrows. The middle furrow flares out at its ends. Surface psilate-scabrate. The exine is 0.8–1.3 µm thick, the three layers of the ectexine are equal. The structure of the infratectal layer is not well discernible by light-microscope.

Polar axis: 23 µm; 22–31 µm.

Remarks: *Trifossapollenites ivoriensis* JARDINÉ and MAGLOIRE 1965 is smaller (17–25 µm). This species was found in the Albian-Aptian-Cenomanian layers of the Ivory Coast, and in the Aptian to Cenomanian of Senegal. *Trifossapollenites magloirae* JAN DU CHÊNE 1978 (in JAN DU CHÊNE, DE KLASZ and ARCHIBONG, 1978) from the Albian-Cenomanian layers of Senegal is similar to our specimens.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) common, Kharga (1-28) common, Maestrichtian, fm. indet.: Oweina (1) common.

SUBTURMA: *POLYPLICATES* ERDTMAN 1952

Form-genus: *Ephedripites* BOLKHOVITINA 1953 ex R. POTONIÉ 1958

KRUTZSCH (1961) contribution to the knowledge of the fossil *Ephedra* pollen grains is very important. Further information was given by PENKOVA (1973). TEM structures from recent *Ephedra* pollens were described by AFZELIUS (1956, 1957) and M. VAN CAMPO and LUGARDON (1973). The infratectal layer in the ridges is granular, and a lamellar endexine is under the ectexine. TREVISAN (1980) published the first SEM and TEM data on Lower Cretaceous *Ephedripites* pollen grains from Italy.

1a. *Ephedripites minimus* AMEROM 1965 subfsp. *minimus, Ephedraceae*
(Plate 1.3., figs. 5–8)

Description: Amb ellipsoidal but sharpened at their poles. Surface smooth. Maximal thickness of the exine is 0.8–1.2 µm. The number of the ridges is 11-13, generally 12. The basis of the ridges is 0.8 µm in width the furrows 0.5 µm.

Polar axis: 22 µm; 21–26 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent.


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1b. *Ephedripites minimus* AMEROM 1965 subfsp. *aegypticus* n. subfsp.
(Plate 1.3., figs. 9–14)

Diagnosis: The specimens of this form-species are 18–20 µm size. The number of the ridges is in general 12, rarely 14.

Subfsp. type: Plate 1.3., figs. 9,10, slide: Farafra-6-2-2-8; cross-table number: 20.2/109.3.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: From Egypt.

Differential diagnosis: The smaller size distinguish well this taxon from the typical forms of this form-species.

Botanical affinity: *Ephedraceae.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) common.

Plate 1.3.

1,2. *Eucommiidites couperi* ANDERSON 1960, slide: Abu Minquar-4-3-6, cross-table number: 5.8/113.3.
3,4. *Eucommiidites couperi* ANDERSON 1960, slide: Abu Minquar-4-3-5, cross-table number: 9.3/110.7.
5,6. *Ephedripites minimus* AMEROM 1965 subfsp. *minimus, Ephedraceae*, slide: Farafra-6-2-2-3, cross-table number: 18.4/118.2.
7,8. *Ephedripites minimus* AMEROM 1965 subfsp. *minimus, Ephedraceae*, slide: Farafra-6-2-2-1, cross-table number: 16.2/109.2.
9,10. *Ephedripites minimus* AMEROM 1965 subfsp. *aegypticus* n. subfsp., *Ephedraceae*, slide: Farafra-6-2-2-8, cross-table number: 20.2/109.3.
11,12. *Ephedripites minimus* AMEROM 1965 subfsp. *aegypticus* n. subfsp., *Ephedraceae*, slide: Farafra-6-2-2-3, cross-table number: 11.2/116.5.
13,14. *Ephedripites minimus* AMEROM 1965 subfsp. *aegypticus* n. subfsp., *Ephedraceae*, slide: Farafra-6-2-2-7, cross-table number: 18.0/120.0.
15,16. *Ephedripites viesenensis* KRUTZSCH 1961, *Ephedraceae*, slide: Farafra-6-2-2-9, cross-table number: 20.9/111.4.
17,18. *Ephedripites viesenensis* KRUTZSCH 1961, *Ephedraceae*, slide: Abu Minquar-4-3-2, cross-table number: 10.9/117.1.
19,20. *Ephedripites brenneri* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-7, cross-table number: 6.4/102.9.
21,22. *Ephedripites brenneri* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-5, cross-table number: 20.8/119.1.
23,24. *Ephedripites ameromii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-3, cross-table number: 4.5/114.4.
25,26. *Ephedripites ameromii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-1-8, cross-table number: 20.1/106.9.
27,28. *Ephedripites coetzeae* n. fsp., *Ephedraceae*, slide: Abu Minquar-4-3-10, cross-table number: 5.6/110.5.
29,30. *Ephedripites coetzeae* n. fsp., *Ephedraceae*, slide: Abu Minquar-4-3-2, cross-table number: 9.4/109.8.
31,32. *Ephedripites virginianensis* BRENNER 1963, *Ephedraceae*, slide: Farafra-6-2-1-8, cross-table number: 7.6/112.6.
33,34. *Ephedripites virginianensis* BRENNER 1963, *Ephedraceae*, slide: Farafra-6-2-1-9, cross-table number: 15.7/105.8.
35,36. *Ephedripites krempii* n. fsp., *Ephedraceae*, slide: Abu Minquar-4-3-8, cross-table number: 8.2/104.7.
37,38. *Ephedripites krempii* n. fsp., *Ephedraceae*, slide: Kharga-1-39-4, cross-table number: 20.1/120.5.
39,40. *Ephedripites crassoides* KRUTZSCH 1961, *Ephedraceae*, slide: Farafra-6-2-2-12, cross-table number: 9.8/109.3.

2. *Ephedripites viesenensis* KRUTZSCH 1961, *Ephedraceae*
(Plate 1.3., figs. 15–18)

Description: Amb ellipsoidal, slightly sharpened at the poles. Surface smooth, or finely scabrate. The exine is 0.8–1.2 μm thick. The number of the ridges is 12–15, generally 14. Width of the ridge base is 1.2–1.3 μm, those of the furrows 0.7 μm.

Polar axis: 28 μm; 25–40 μm.

Remarks: The specimens of Egypt are larger than those of Viesen. There is some similarity with *E. dudarensis* DEÁK 1964, but this species has only 6–8 ridges, which is a very distinctive and characteristic feature.

Occurrence and frequency in the samples investigated from Egypt: Lower Campanian: Duwi infrequent, Maestrichtian, Duwi infrequent, Maestrichtian, Nubia Sandstone: Farafra (6-2-2) common, Farafra (6-2-1) infrequent, Farafra (11) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

3. *Ephedripites brenneri* n. fsp.
(Plate 1.3., figs. 19–22)

Diagnosis: Ellipsoidal pollen grains with sharpened poles. The outer exine layer often separate from the inner ones. Surface is smooth, the exine is 1.2–1.6 μm thick. The number of the ridges is 14–16, in general 16. The width of the ridges is 0.7–1.1 μm, the furrows are 0.5–0.7 μm in width.

Polar axis: 25 μm; 20–36 μm.

Holotype: Plate 1.3., figs. 19,20, slide: Farafra-6-2-2-7; cross-table number: 6.4/102.9.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Dr. G. BRENNER, excellent investigator of the Cretaceous sporomorphs.

Differential diagnosis: *E. chaloneri* BRENNER 1968 has 6–8 alternating ridges and furrows.

Botanical affinity: *Ephedraceae*.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Abu Minquar (4-3) infrequent.

4. *Ephedripites ameromii* n. fsp.
(Plate 1.3., figs. 23–26)

Diagnosis: Amb ellipsoidal, the poles are slightly sharpened, sometimes the outer exine layer is separated from the inner ones. The surface is smooth. The exine is 0.8–1 μm thick on the sides, and 1.3–2 μm on the apices. The number of the ridges is 16–18, generally 18. The width of the ridges is 0.8 μm, the furrows up to 1 μm. In several specimen there are small nodules on the ridges near the poles, but this is not a characteristic feature of this form-species.

Polar axis: 35 μm; 31–45 μm.

Holotype: Plate 1.3., figs. 23,24, slide: Farafra-6-2-2-3, cross-table number: 4.5/114.4.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Dr. VAN H. W. J. AMEROM.

Differential diagnosis: *E. treplinensis* KRUTZSCH 1961 is 36 μm long and has 12 ridges, *E. winiae* AMEROM 1965 is 42–51 μm long and is therefore larger than our new species. It also has more ridges, with total about 30 in number.

Botanical affinity: *Ephedraceae.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent.

5. *Ephedripites coetzeae* n. fsp.
(Plate 1.3., figs. 27–30)

Diagnosis: Amb narrow, ellipsoidal. Surface smooth, the exine is 1 μm thick at the poles and on the sides. The number of the ridges is 11–14, generally 12. The width of the ridges is 1.2–1.4 μm, those of the furrows are 1–1.6 μm.

Polar axis: 42 μm; 34–43 μm.

Holotype: Plate 1.3., figs. 27,28, slide: Abu Minquar-4-3-10, cross-table number: 5.6/110.5.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. J. A. COETZEE.

Differential diagnosis: The described new fsp. is larger, than *E. treplinensis* KRUTZSCH 1961. The larger size and the number of ridges clearly separate this species from *E. ameromii* n. fsp. The ridge number also distinguishes this species from *E. virginianensis* BRENNER 1963.

Botanical affinity: *Ephedraceae.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Kharga (1-39) infrequent.

6. *Ephedripites virginianensis* BRENNER 1963, *Ephedraceae*
(Plate 1.3., figs. 31-34)

Description: Amb ellipsoidal, with only slightly sharpened poles. Surface smooth or scabrate. The exine is 1.2–1.4 μm thick on the sides, and 1.5–2 μm on the poles. The number of the ridges is 14, the width of the ridges is 1.2–1.5 μm, the furrows are 0.5–0.7 μm in width.

Polar axis: 42 μm; 35–45 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent.

7. *Ephedripites krempii* n. fsp.
(Plate 1.3., figs. 35–38)

Diagnosis: Amb ellipsoidal, poles slightly sharpened. Surface smooth or scabrate. The exine is 1–1.6 μm thick. The number of the ridges is 7–8, generally 8. The sides are 0.8–1.2 μm, the furrows, 2–3.5 μm wide.

Polar axis: 39 µm; 34–44 µm.

Holotype: Plate 1.3., figs. 35,36, slide: Abu Minquar-4-3-8, cross-table number: 8.2/104.7.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In memoriam of Prof. Dr. G. O. W. KREMP, excellent investigator of the fossil sporomorphs.

Differential diagnosis: *E. wolkenbergensis* KRUTZSCH 1961 is 40–42 µm long, with 10–12 ridges. *E. virginianensis* BRENNER 1963 is 35–45 µm long, with generally about 14 ridges.

Botanical affinity: *Ephedraceae.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

8. *Ephedripites crassoides* KRUTZSCH 1961, *Ephedraceae*
(Plate 1.3., figs. 39,40)

Description: Amb ellipsoidal with slightly sharpened poles. Surface scabrate. Exine is 2–2.3 µm thick. The number of the ridges is 10–12. Width of the ridges is 0.7–1.3 µm, those of the furrows, 1–2.5 µm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Farafra (11) infrequent, Abu Minquar (4-3) infrequent, Maestrichtian fm. indet.: Oweina (1) infrequent.

9. *Ephedripites boltenhagenii* n. fsp.
(Plate 1.4., figs. 1–4)

Diagnosis: Amb ellipsoidal with sharpened poles. Surface smooth or scabrate. The exine is 1 µm thick on the sides and 2–2.5 µm on the poles. The number of the ridges is 14–15, generally, 16. The ridges are 0.7–1.3 µm, the furrows, 0.4–0.6 µm in width.

Polar axis: 46 µm; 32–48 µm.

Holotype: Plate 1.4., figs. 1,2, slide: Farafra-6-2-2-1, cross-table number: 11.8/100.6.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Dr. E. BOLTENHAGEN, excellent investigator of the Cretaceous sporomorphs of Equatorial Africa.

Differential diagnosis: *E. frankfurtensis* KRUTZSCH 1961 is 37 µm long, with 17 ridges, *E. montanaensis* BRENNER 1968 is 52/57/62 µm long, with 14–18 ridges. Therefore it is the larger size, which separates this species from *E. boltenhagenii* n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Farafra (11) infrequent, Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

10. *Ephedripites multicostatus* BRENNER 1963, *Ephedraceae*
(Plate 1.4., figs. 5–10)

Description: Amb ellipsoidal, with sharpened poles. Surface scabrate. The exine is 0.5–0.8 μm on the sides and 1.6–2 μm on the poles. The number of the ridges is 19–22, generally 20. The width of the ridges is 0.5–1.2 μm, those of the furrows, 0.6–1.4 μm.

Polar axis: 38 μm; 33–48 μm.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Abu Minquar (4-3) infrequent.

11. *Ephedripites regularis* VAN HOEKEN-KLINKENBERG 1964, *Ephedraceae, Ephedra*
(Plate 1.4., figs. 11–14)

Description: Amb ellipsoidal. Surface scabrate or finely punctate. The exine is about 1 μm thick on the sides and 1.7–2.5 μm at the poles. The number of the ridges is 14–16. The ridges are generally 1 μm in width, the furrows, 1.6–2 μm.

Polar axis: 56 μm; 50–60 μm.

Remarks: VAN HOEKEN-KLINKENBERG (1964) described this species from the Maestrichtian layers of Nigeria. The number of the ridges was not indicated in the description but from her photomicrographs it appears to be about 14.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent.

12. *Ephedripites rakosii* n. fsp.
(Plate 1.4., figs. 15–18)

Diagnosis: Amb ellipsoidal, with sharpened poles. Surface scabrate. The exine is 1–1.5 μm thick on the sides, and 2–3 μm at the poles. The number of the ridges is 14–18, generally 16. Width of the ridges is 0.5–2 μm and those of the furrows 1–1.5 μm.

Polar axis: 54 μm; 41–56 μm.

Holotype: Plate 1.4., figs. 15,16, slide: Farafra-6-2-2-8, cross-table number: 10.7/110.8.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Dr. L. RÁKOSI excellent investigator of the Hungarian paleogene sporomorphs.

Differential diagnosis: *E. schoenevaldensis* KRUTZSCH 1961 is 50 μm long, with 10 ridges, *E. procerus* BRENNER 1968 is 79 μm long, with 14–18 ridges, *E. caichigiiensis* VOLKHEIMER and QUATTROCHIO 1975 (syn.: *Equisetosporites caichigiiensis* n. sp., p. 236, pl. 10, figs. 15,16, pl. 11, figs. 1–4) is 32–68 μm in size, *E. nobilis* (SRIVASTAVA 1968) n. comb. (syn.: *Gnetaceaepollenites nobilis* n. sp., p. 214, fig. 1) has 10–12 ridges, and the size is a little larger.

Botanical affinity: *Ephedraceae.*

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Kharga (1-39) infrequent.

13. *Ephedripites jansoniusii* n. fsp.
(Plate 1.4., figs. 19–22)

Diagnosis: Amb ellipsoidal, with sharpened poles. Surface smooth or scabrate. The exine is 1–1.3 μm thick on the sides and 2.5–3 μm on the poles. The number of the


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ridges is 26–31, generally 30,31. The width of the ridges is 1–1.6 μm, those of the furrows are 0.3–0.6 μm.

Polar axis: 48 μm; 40–57 μm.

Holotype: Plate 1.4., figs. 19,20, slide: Farafra-6-2-2-5, cross-table number: 15.6/102.9.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Stratum typicum: clayey brown coal.

Derivatio nominis: In honour of Dr. J. JANSONIUS.

Differential diagnosis: The number of the furrows (which is higher) separates this form-species from *E. rakosii* n. fsp.

Botanical affinity: *Ephedraceae*.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent, Farafra (11) infrequent.

14. *Ephedripites winiae* AMEROM 1965 subfsp. *magna* n. subfsp.
(Plate 1.5., figs. 1,2)

Syn.:

1974 *Ephedripites* sp. (Type 276) BRENNER, pl. 3, fig. 12.

Diagnosis: Amb ellipsoidal. Surface smooth or scabrate. The exine is 0.9–1.2 μm on the sides and on the apices. The number of the ridges is 30–34, generally 32. The width of the ridges is 0.3–0.5 μm, those of the furrows are 0.3–0.4 μm.

Polar axis: 63 μm; 65–74 μm.

Subfsp. type: Plate 1.5., figs. 1,2, slide: Farafra-6-2-1-6, cross-table number: 6.3/114.6.

Locus typicus: Farafra, Maestrichtian, Nubia Sandstone.

Plate 1.4.

1,2. *Ephedripites boltenhagenii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-1, cross-table number: 11.8/100.6.

3,4. *Ephedripites boltenhagenii* n. fsp., *Ephedraceae*, slide: Farafra-11-2, cross-table number: 18.6/109.8.

5,6. *Ephedripites multicostatus* BRENNER 1963, *Ephedraceae*, slide: Abu Minquar-4-3-10, cross-table number: 15.0/106.8.

7,8. *Ephedripites multicostatus* BRENNER 1963, *Ephedraceae*, slide: Farafra-6-2-2-12, cross-table number: 10.7/112.9.

9,10. *Ephedripites multicostatus* BRENNER 1963, *Ephedraceae*, slide: Farafra-6-2-1-5, cross-table number: 16.3/102.8.

11,12. *Ephedripites regularis* VAN HOEKEN-KLINKENBERG 1964, *Ephedraceae, Ephedra*, slide: Farafra-6--2-2-12, cross-table number: 4.3/112.8.

13,14. *Ephedripites regularis* VAN HOEKEN-KLINKENBERG 1964, *Ephedraceae, Ephedra*, slide: Farafra 6--2-2-1, cross-table number: 4.3/112.8.

15,16. *Ephedripites rakosii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-8, cross-table number: 10.7/110.8.

17,18. *Ephedripites rakosii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-10, cross-table number: 17.8/115.2.

19,20. *Ephedripites jansoniusii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-5, cross-table number: 15.6/102.9.

21,22. *Ephedripites jansoniusii* n. fsp., *Ephedraceae*, slide: Farafra-6-2-2-2, cross-table number: 14.8/117.8.

Plate 1.5.

1,2. *Ephedripites winiae* AMEROM 1965 subfsp. *magna* n. subfsp., *Ephedraceae, Ephedra*, slide: Farafra--6-2-1-6, cross-table number: 6.3/114.6.
3,4. *Steevesipollenites binodosus* STOVER 1964, slide: Abu Minquar-4-3-3, cross-table number: 15.6/118.5.
5,6. *Steevesipollenites binodosus* STOVER 1964, slide: Kharga-1-39-5, cross-table number: 7.9/114.1.
7,8. *Steevesipollenites khargaensis* n. fsp., slide: Kharga-1-39-5, cross-table number: 12.7/102.3.
9,10. *Steevesipollenites khargaensis* n. fsp., slide: Abu Minquar-4-3-8, cross-table number: 9.6/102.6.
11,12. *Steevesipollenites elsikii* n. fsp., slide: Abu Minquar-4-3-2, cross-table number: 13.4/108.8.
13,14. *Stoveripollenites africanus* n. fgen. et fsp., slide: Abu Minquar-4-3-3, cross-table number: 18.8/102.5.

Stratum typicum: clay.

Derivatio nominis: From its relatively large size.

Differential diagnosis: *E. translucidus* DEÁK and COMBAZ 1967 has 30–35 ridges, which is the same as that in our pollen grains. However the size is only 45 μm and this represents the single characteristic feature for distinction.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Farafra (6-2-2) infrequent, Farafra (6-2-1) infrequent.

Form-genus: *Steevesipollenites* STOVER 1964

Polyplicate pollen grains with appendices on the poles. There are several transitional forms between *Ephedripites–Welwitschiapites* and *Steevesipollenites*. These pollen grains seem to be an important elements of the Mesozoic spore-pollen assemblages of the Southern Hemisphere.

1. *Steevesipollenites binodosus* STOVER 1964
(Plate 1.5., figs. 3–6)

Description: Amb ellipsoidal, with sharpened poles, and 2-3 μm long, and about 3.5 μm wide appendices. Surface scabrate. The number of the ridges is 12–18, one ridge is 1–2.5 μm wide, the furrows are 1.8–2.5 μm wide.

Polar axis, with appendices: 31 μm; 25–36 μm.

Occurrence and frequency in the samples investigated from Egypt: Lower Campanian: Duwi infrequent; Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent.

2. *Steevesipollenites khargaensis* n. fsp.
(Plate 1.5., figs. 7–10)

Diagnosis: Amb ellipsoidal, the polar thickenings (the appendices) are not prominent, these are 2.5-3 μm thick, and 5-7 μm wide. Surface scabrate, the exine is 1-1.5 μm thick on the sides. The number of the ridges is 10–18, their width is 1.5-2 μm, those of the furrows are 1-1.2 μm.

Polar axis, with thickenings: 45 μm; 38-49 μm.

Holotype: Plate 1.5., figs. 7,8, slide: Kharga-1-39-5, cross-table number: 12.7/102.3.

Locus typicus: Kharga, Maestrichtian, Nubia Sandstone.

Stratum typicum: clay.

Derivatio nominis: From Kharga, from the locality type.

Differential diagnosis: The larger size and the flat appendices separates this species from *S. binodosus* STOVER 1964.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) common, Kharga (1-28) infrequent.

3. *Steevesipollenites elsikii* n. fsp.
(Plate 1.5., figs. 11,12)

Diagnosis: Pollen grains with elongated form; 1.5-2 μm thick and 7-10 μm wide disc--forming thickenings on the poles. The exine is 0.8-1.3 μm thick on the sides. Surface psilate or scabrate. The number of the ridges is 10 about, its width is 1.3-2 μm; the furrows are generally 1.5 μm in width.

Polar axis with thickening: 35 μm; 30–35 μm.

Holotype: Plate 1.5., figs. 11,12, slide: Abu Minquar-4-3-2, cross-table number: 13.4/108.8.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour of Dr. W. C. ELSIK.

Differential diagnosis: The number of the ridges and the disc-forming appendices clearly distinguish this species from *S. khargaensis* n. fsp.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent.

Form-genus: *Stoveripollenites* n. fgen.

Form-genus type: *Stoveripollenites africanus* n. fgen. et fsp.
(Plate 1.5., figs. 13,14)

Diagnosis: Polyplicate ellipsoidal pollen grains. The ridges are sinuous. The valleys are much larger than the ridges.

Form-genus type: Plate 1.5., figs. 13,14, slide: Abu Minquar-4-3-3, cross-table number 18.8/102.5.

Locus typicus: Abu Minquar, Maestrichtian, Nubia Sandstone.

Stratum typicum: coaly clay.

Derivatio nominis: In honour to Dr. L. E. STOVER, excellent investigator of the Cretaceous sporomorphs.

Differential diagnosis: The ridges of *Singhia* SRIVASTAVA 1968 are bifurcating, the valleys of *Ephedripites* (*Spiralipites*) are narrow and in general narrower than the width of the muri.

1. *Stoveripollenites africanus* n. fsp.
(Plate 1.5., figs. 13,14)

Diagnosis: Amb ellipsoidal, the ridges are sinuous, their number is 8-10 μm. The ridges are 2 μm high and 2-2.7 μm in width, those of the furrows are 3-5 μm. Its surface is punctate or finely granulate.

Polar axis: 30 μm; 26-34 μm.

Holotype, locus typicus, stratum typicum, see previously.

Derivatio nominis: From Africa.

Occurrence and frequency in the samples investigated from Egypt: Maestrichtian, Nubia Sandstone: Abu Minquar (4-3) infrequent, Kharga (1-39) infrequent, Kharga (1-28) infrequent.

To be continued

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